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Leveraging Digital Technologies to Bridge the Digital Divide and Advance Financial Inclusion

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Abstract: The aim of this study is to analyze how the digital divide can be shortened among various socio-economic conditions combining with the help received from Artificial Intelligence, cloud based financial technologies which further help improve efficiency and availability of these financial systems. Basing on a systematic and a thorough evaluation of prior studies and knowledge on the topic, various key research voids were identified which included the limited amount of empirical evidence and the lack of cross regional evidence as well as the algorithmic bias which was not accounted for. To find out more, this study implemented a methodological framework which involved data collection through a sample size of 110 respondents, each of them having chosen through purposive sampling in order to obtain the best possible results through data analysis followed by performance comparisons and validation techniques. The internal consistency seen was strong with the Cronbach's alpha values being of 0.872, 0.907 and 0.905 across the different constructs, validating the measurement model. This showcases that a massive role is being played by the inclusive digital technologies and frameworks in order to promote sustainable financial inclusion. However, there are numerous obstacles such as the significant differences in infrastructure of different places and cultural barriers which restrain equitable access to these financial services. This research contributes a framework that combines technology and governance and presenting insights for policymakers, helping them develop financial systems in regions which are still developing to be secure, transparent and most importantly inclusive for all.

Keywords: Financial Inclusion; Digital Divide; Digital Financial Services; Fintech; Digital Literacy; Inclusive Growth

I. Introduction

In recent years, the importance of digital finance has grown exponentially and has become an important tool to eliminate financial exclusion and enabling broader access in developing and developed economies. As these economies shift towards these digital platforms due to increasing uncertainty in the world, understanding the role of digital finance and technologies to bridge the digital divide becomes Quintessential. This paper aims and covers the basis of digital finance which intends to achieve financial inclusion and follow along the guidelines of the sustainable development goals whilst closing in the gap caused by the digital divide between different classes of people and different economies, making financial inclusion a need for many such economies. This can be simplified using financial alterations and innovating new financial models whilst also closing in the digital divide by using technologies like Mobile banking, Blockchain Technologies which boosts access to all consumers and producers everywhere establishing an equitable platform for everyone to take part in financial transactions promoting financial inclusions and having transparency between users which in turn benefits the department of Cyber Justice as well [1].

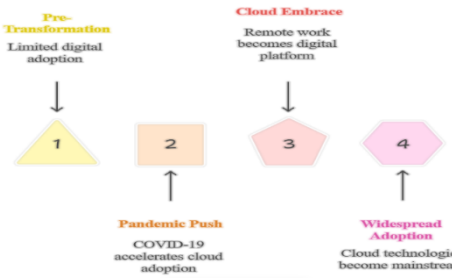

Figure 1: Flowchart showing the Digital Transformation Journey

More than 80 countries have launched large-scale digital financial services with the use of cell phones due to which, millions of people who only relied on cash-based transactions or were excluded or underserved were able to shift to digital financial services like transfer, savings, credit and even securities using their cell phones bridging the digital divide which seems to be an achievable goal in recent times with the emergence of newer innovations [2].This flowchart given in Figure 1 displays the stages of the digital transformation starting from the limited digital adoption, progressing step by step towards achieving widespread adoption where remote work and digital platforms become one. Moreover, Digital Financial Inclusion has numerous benefits, especially for people at the bottom of the economic pyramid as these technology-based changes helps secure low-cost services whilst reaching a vast portion of the population which are unbanked or underbanked individuals which would cause a boost in economic activity and encourage economic growth in the region showing a positive impact and connecting everyone in an economy on a platform fostering growth [3]. An early example of this is "the worldwide spending on digital transformation reaching 1.85 trillion U.S. dollars in 2022, up over 16 percent in a single year". Many businesses were incentivized by the (COVID-19) pandemic to embrace cloud technologies which enabled remote working on a digital platform which proved to be a success causing "Over 90 percent of organizations worldwide had implemented cloud technologies as of 2023, the highest adoption rate of any emerging technology, with global public cloud spending estimated to have surpassed 560 billion U.S. dollars worldwide" [4].

Advancements have taken a step further in recent years with technologies having potential to bridge the digital divide making huge changes in the Banking sector, powered by FinTech involving Artificial Intelligence (AI) and Blockchain technology. Other Innovations like Robo-advisors are making processes much easier and simpler and are more efficient making banking services completely virtual and customised according to the customer which has huge upside potential when targeting a larger number of people trying to close the digital divide. The fusion of all these technologies is essential enhancing accessibility whilst making the systems more secure and sustainable [5]. Countries are also now slowly transitioning to digital financial inclusion as they consider it to be a strong pillar to rely and further develop their economy and also in a hope to attract different parts of the society which the traditional financial systems are not able to achieve [6]. Not only that FinTech innovations can make significant impact such as overcoming obstacles like the lack of physical access to financial institutions, expensive running costs, and the complexity of tasks. They also have democratized access to credit by connecting investors directly to shareholders or borrowers reducing borrowing costs whereas with the use of blockchain technologies, the medium of financial transactions can be secure, have full transparency whilst being cost effective [7].

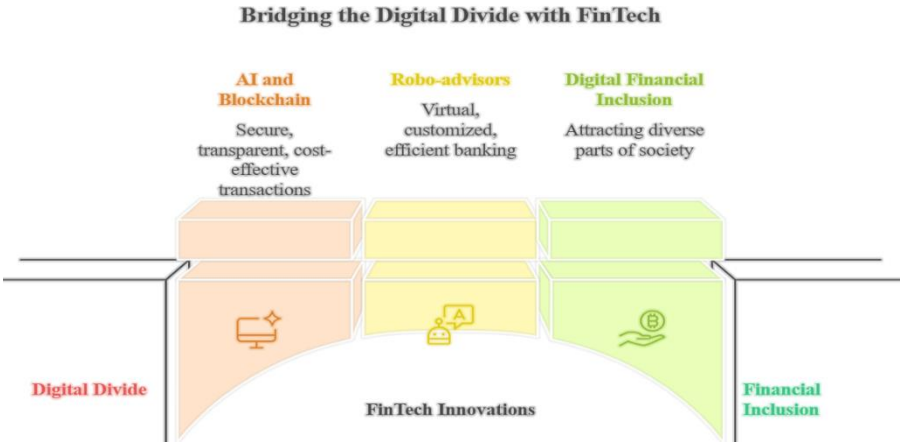

Figure 2: Steps to bridge the digital divide with Fintech

Figure 2 shows how FinTech innovations like AI & blockchain act as a bridge between the digital divide and financial inclusion by making them more efficient and accessible which helps include people in the financial systems. Furthermore, this paper views the obstacles in order to obtain financial inclusivity and bridging the digital divide like the lack of infrastructure, the prerequisite of digital literacy which is a major problem in many countries around the world and different regulations of each country and their willingness to trust and implicate digital finance in their respective economies shows that digital finance is a powerful tool which can make a huge difference if collaborated upon having a positive socio economic effect. Nevertheless, these efforts suffer majorly

from the obstacle of digital divide to which little attention is given as existing literature often focuses mainly on drivers of acceptance. “An estimated 1.7 billion adults still lack access to formal financial services, with the majority residing in low- and middle-income countries” [8]. This still makes financial crucial a huge problem causing an equality deficit whilst also hindering poverty eradication which is not beneficial for the long term societal transformational objectives. This study aims to Leverage digital technologies in order to bridge the digital divide whilst advancing financial inclusion [9].

II. Literature Review

The digital divide is conceptualized as a major obstacle for FinTech solutions and advancements which ideally drive to a greater level of financial inclusion around the world particularly for the ones that are unbanked. While technologies have been designed and curated together in order to try and resolve and increase access to financial services across the world, the digital divide acts like a barrier to having effective changes and improvements. According to the World Bank’s Global Findex database, about 1.7 billion adults were unbanked in 2017. The Financial Technologies have caused a transformative shift in many industries having new, efficient methods which empower economic growth whilst fostering inclusivity. However, these technologies are yet to bridge the digital divide among this big of a population which lack access to them. These are not only caused due to the lack of capital access but also due to geographical barriers that inhibit the growth of these digital services that try and face these challenges. In South Sudan, for instance, only 9% of the adults had a bank account. Similarly, about 70% of the population in Latin America is unbanked or underbanked. Even educational disparities where there is a stark difference between the population may challenges to further rise [10].

Despite the recent increase in attention of the digitization which have the primary motive of securing digital platforms for safe financial transactions that eliminate the obstacles of distance which a large population still faces due to their geographical remoteness and education disparities causing them to need more time to adjust to different interfaces and accept them as well. according to the International Finance Corporation, over 200 million small and medium enterprises (SMEs) in developing countries lack access to financial services. If overcome, it would strengthen the reach of the banking system thus becoming a topic deeply researched upon and discussed about also due to its crucialness [10-2]. This however has put a halt on the traditional ways of banking which has unlocked the obstacle of providing capital for underserving populations. These successful attempts have proved why adaptable FinTech solutions are fundamental for addressing the digital divide while addressing particular economic gaps as well.

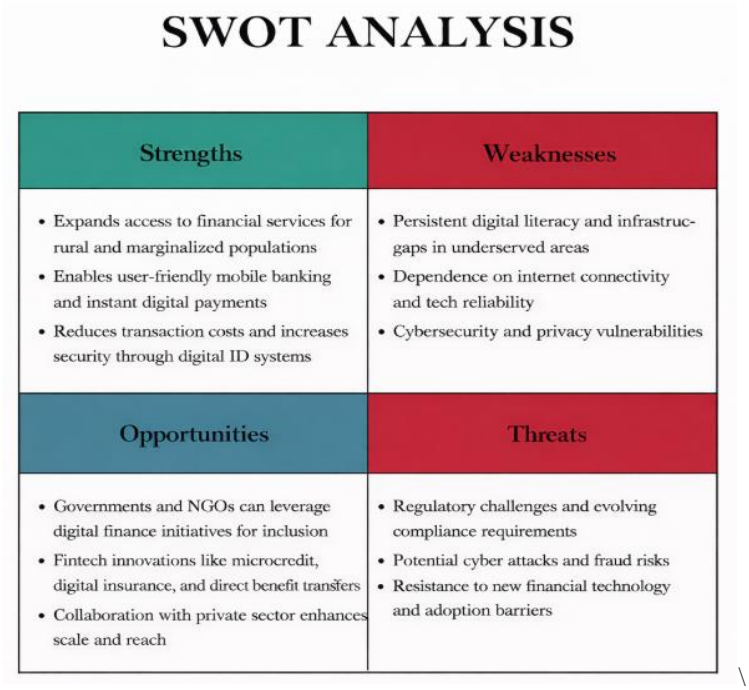

Figure 3: SWOT analysis of the digital tools used for financial inclusion

Investment in AI across the financial sector has witnessed remarkable growth, with estimated spending reaching 45 billion U.S. dollars in 2024, a substantial increase from 35 billion in 2023. However, the extent of which the new technologies have an effect are based on various factors depending on the basis of how adaptable the digital financial service really is in terms of the positive effect on the consumers and the general population Figure 3 shows a SWOT analysis highlights the strengths, weaknesses, opportunities, and threats of leveraging fintech innovations to bridge the digital divide and promote inclusive finance. It provides a structured framework to evaluate internal capabilities and external challenges associated with digital financial transformation. Most often Technological innovations are what really make the financial services really effective and adaptable whilst being easy to use. Although technological innovations play a big role, other factors also play a big role such as inflation, trade and GDP. Scholars also emphasize that strong policy frameworks are a mandatory requirement to attain digital financial inclusion as well and make sure that the adoption of new technology driven initiatives are constructive in bridging the digital divide [11].

The barriers of digital divide among other major concerns such as security concerns and infrastructure deficits in places around the world are what really obstruct innovations like AI, Blockchain and mobile money which once again emphasizes how digital financial literacy is essential for trade not only one a consumer and producer basis but also between countries to navigate these complexities faced in online financial services. By advancing these services by leveraging machine learning and natural language processing, Financial institutions can achieve more accurate data driven results which will be of immense help in decision making and in other sectors as well like its creditworthiness and chatbots enhancing service delivery [12]. In 2024, nearly 70 percent of financial services companies reported AI-driven revenue increases, with most achieving 5-10 percent revenue growth attributable to AI implementations. Whilst the innovations are looked upon in order to solve these issues, the adoption of these innovations is critical in order for the innovation to succeed. There are already elaborate theories in current literature specifically addressing how the digital divide is a significant challenge but tends to miss on the foundational elements of adoption and literacy. These include the socio-technical barriers which make the cutting-edge technologies still in their early stages without a clear pathway ahead. Concerns like privacy, trust and ethical issues are obstacles looked over [13].

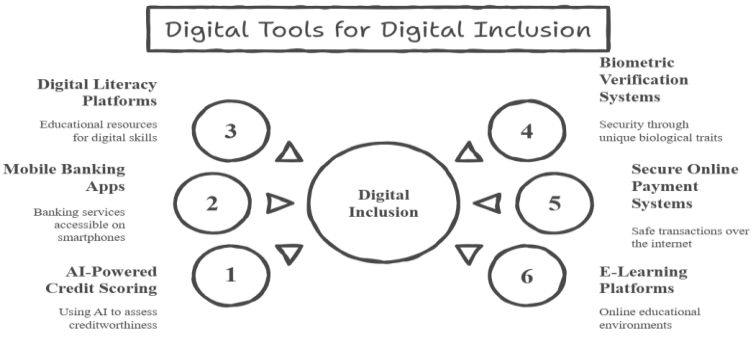

Figure 4: Mind map showing the different digital tools fostering digital inclusion

Figure 4 presents key digital tools that collectively contribute to advancing digital inclusion across societies. It illustrates how technologies such as mobile banking, AI-powered credit scoring, biometric verification, secure payment systems, and digital literacy platforms work together to enhance accessibility, security, and financial participation. While adopting these technologies may have their own challenges the adoption is required due to the role they play in fostering economic growth and development. They have consistently shown success in advancing financial inclusion among emerging nations where platforms that are based on the internet and mobile banking play a huge part in broadening their access but the extent of success once again relies on regional digital literacy and infrastructure stability in the long term [14].

Meanwhile, the prevalent integration of Information and communication Technology (ICT) in urban areas is also a critical mechanism used to gain further inclusivity through the method od Digitalization which includes the transforming from the traditional methods to more new conventional ways like contactless smart cards and mobile ticketing all of which avoids cost-intensive cash turnover whilst simultaneously broadening the reach of financial distribution networks [15]. Other tools of digitalization include the integration of blockchain providing a strong

framework in order to bridge the digital divide by joining decentralized security with accurate decision making, streamlining banking operations and significantly decreasing the chance of fraud allowing the underserved populations to receive the benefits of these services as well. Over 90 percent of organizations worldwide had implemented cloud technologies as of 2023, the highest adoption rate of any emerging technology, with global public cloud spending estimated to have surpassed 560 billion U.S. dollars worldwide.Systemic barriers to financial inclusion manifest across access and results primarily driven by economic constraints especially the gender digital divide which is a major problem in rural areas where interaction with technology across all areas of life is restricted which automatically prevents the usage of digital finance services acting as a barrier in the distribution networks of digital finance. These regional nuances are significant yet very common in rural areas in Africa and Asia primarily.

.Figure 5: Synthesis of research on digital innovation and inclusion strategies

Serial No	Key Findings	Research Gap	Digital Technology	Limitations	Future Scope
[10]	Digital platforms improve access and financial empowerment outcomes	Limited empirical evidence across diverse developing regions contexts	Mobile fintech applications and digital payment systems secure	Infrastructure deficits constrain scalability and sustained adoption rates	Expand cross country longitudinal impact evaluations for policy
[11]	Technological innovation fosters equitable financial service access globally	Insufficient integration of regulatory policies	Digital banking infrastructure and interoperable payment networks ecosystems	Early stage adoption limits measurable socioeconomic impacts outcomes	Develop inclusive policies supporting technology diffusion strategies nationally
[12]	Artificial intelligence enhances credit access in emerging economies	Limited assessment of algorithmic bias implications across populations	AI driven analytics and alternative data scoring models	Data quality issues undermine predictive reliability accuracy outcomes	Strengthen ethical governance and transparent algorithm design standards
[13]	Digital literacy significantly influences fintech adoption behavior patterns	Causal relationships between literacy and resilience unclear outcomes	Mobile applications and user centered interface systems platforms	Self reported survey data restrict generalizability validity scope	Promote integrated financial and digital education programs nationally
[14]	Digital financial services reduce poverty vulnerabilities levels significantly	Limited cross country comparative inclusion analysis studies	Online payment platforms and mobile money services ecosystems	Cybersecurity risks threaten sustained user trust confidence levels	Enhance security frameworks and consumer protection regulations globally
[15]	Gender disparities persist within digital financial ecosystems access	Insufficient focus on women specific technological barriers contexts	ICT platforms supporting women inclusive finance solutions initiatives	Socio cultural norms hinder equitable technology usage adoption	Design gender responsive digital inclusion strategies policies globally
[16]	Financial inclusion builds long term financial capability resilience	Limited empirical linkage between inclusion and capability outcomes	Community banking platforms and digital advisory tools services	Short term program evaluations restrict impact assessment depth	Integrate capability metrics within inclusion policies frameworks nationally
[17]	Digital governance frameworks influence inclusive development outcomes significantly	Fragmented policy coordination limits technology effectiveness evaluation studies	Smart city technologies and data driven systems platforms	Urban rural disparities reduce equitable access opportunities significantly	Promote integrated urban digital inclusion models governance reforms
[18]	Digital transformation enhances financial system resilience stability outcomes	Longitudinal evidence on digital inclusion impacts scarce globally	Blockchain fintech platforms and secure identity systems integration	Regulatory uncertainty constrains innovative technology deployment scalability efforts	Conduct multidisciplinary research on sustainable inclusion strategies globally

Figure 5 presents a structured comparative overview of selected research studies examining the role of digital technologies in advancing financial inclusion. It summarizes key findings, research gaps, technological focus areas, limitations, and future research directionsEven European countries are affected by this as in 2024, only about 11 percent of companies in Poland stated they had no barriers to digital transformation. This combined with other socio-cultural barriers and socio-technical factors like cybersecurity further effect the digital divide, inhibiting it to decrease as an intersectional approach is necessary to mitigate these challenges may it be geographical or socio-cultural [16]. Not only that Digitalization also opens the door to systemic risks which includes frauds and exclusions requiring a mandatory framework wherein it is paired with strong and robust cybersecurity and digital literacy training. Bridging these gaps may take a long time as it needs a combination of affordable access, targeted education along with protective mechanisms for consumers needing a collaboration of government, academia and industry in order to close the gap [17].

An effective framework requires digital framework from accumulated data of people-centred governments that explicitly address the rights of vulnerable and underrepresented populations. Regulatory frameworks can diminish socio-economic segregation and the oppression of the “new urban poor” by combining participatory stakeholder interaction and citizen-centricity. Even scholarships in the field of education now require holistic inclusion models which primarily focus on bridging the digital divide and establishing equal opportunity which if succeeded would grow the financial inclusivity in society. Eventually, the transition towards participatory decision making would ensure that the digital technologies would catalyse broad-based financial inclusion [18]. The global digital transformation market is projected to reach $1,316.62 billion in 2025, with a compound annua l growth rate (CAGR) of 28.5% from 2025 to 2030. This growth is driven by the increasing adoption of technol

ogies such as AI, cloud platforms, and intelligent automation. Also, the optimization of digital infrastructure in order to bridge the persistent socio-cultural problems must align with the sustainable development goals to ensure sustainable economic growth. Moreover, widespread studies on the results of financial education is essential in order to enhance the adoption of these services, especially among marginalized populations forming a more inclusive global financial ecosystem.

III. Research Methodology

This study uses a quantitative research method to look into the relationships among key variables influencing digital transformation along with financial inclusion outcomes. This research model is verified using real data via the partial least squares structural equation modelling (PLS-SEM) which is modelling method based on variance and is used widely used to analyse and detect connections and complex relationships between latent constructs and observed variables. This approach methodical in nature allows one to evaluate the measurement quality of the variables in a single model and the relationships between them. This research methodology adopts a process which begins with the formation of the conceptual framework which is relied on by the current literature based on financial inclusion and the adoption of different technologies. This then lead to the design of the research instrument which was the questionnaire in this case which was used for data collection from target respondents, evaluating the measurement model and structural model which consequently lead to the testing of the hypothesis and predictive analysis. This type of methodology not only ensures evidence-based testing whilst also maintaining research quality of the proposed hypothesis. Partial Least Squares Structural Equation Modelling was selected due to its focus on forecasting and predicting research which involves models complex in nature with multiple latent constructs and indicators. This sets PLS-SEM apart from the others as its is not based on covariance-based structural equation which highlights theory confirmation, whereas in the case of PLS-SEM it maximises the variation explained and its dependent variables which makes it fitting for studies trying to identify key drivers influencing outcomes. Moreover, PLS-SEM also is efficient with small to medium sample sizes due to it not needing any strict assumptions which increases is application in research settings.

Within this framework there two key parts with are being examined simultaneously which are the measurement model and the structural model. The measurement model which is also known as the outer model which evaluates the how consistent and reliable the variables are by observing how well the questionnaire represents what it is meant to measure. This means ensuring that all questions correctly measure the specific research question and make sure the concept does not overlap with each other. The structural model also called the inner model looks into the expected relationships among the latent constructs and decides the extent of the effect on the dependent variables due to the independent variables. This dual evaluation provides a deep understanding of the strength of the theoretical relationships proposed and the measurement quality of the constructs [19] [20].The respondents for this study mainly consisted of business owners and professionals who worked in fields where the dependency and inclusion of digital technologies is increasing. These industries include manufacturing and logistics which helps employ a purposive sampling technique which makes sure that the respondents have certain relevant experiences benefitting the study with their insights on the adoption of digital and financial technologies within their respective industries. The appropriateness of the sample size was selected by using the methods like the G*Power statistical power analysis and the 10-times rule for PLS-SEM which are both widely agreed methods. These are used in order to obtain the least number of observations required to identify statistically significant effects in these models. This analysis lead to the minimum number of 81 responses which was exceeded in order to notice effect sizes at the medium level at a 95% confidence rate. While the threshold advised is slightly greater than that of the final sample size, this study was able to gather 78 responses from business owners throughout India which places it within an acceptable range for exploratory research using PLS-SEM. The people who answered the survey where from a wide range of fields and organisations hence providing a accurate empirical basis in order to assess the research questions.

The questionnaire was specifically structured to measure the important constructs of the conceptual model including both the demographic information and the respondent's perspective related to the technological adoption and financial inclusion. The factors measured in the questionnaire included AI Technology Adoption (AIT), Blockchain Implementation (BCI), Cloud-based FinTech Services (CFS), Policy Framework Effectiveness (PFE), Financial Literacy Initiatives (FLI), Digital Infrastructure Development (DID), and Financial Inclusion Outcomes

(FIO). These factors were recorded using items which were previously tested and accurate in the fields of technology adoption, human–robot interaction, financial technology, and organizational technology implementation with minor changes made in order to make sure that the items were suitable for the specific goals of this study. The questionnaire used a five-point Likert scale to measure the respondent's perspective ranging from strongly disagree to agree with there being a total of fifteen such Likert-scale items being selected in order to secure the different viewpoints of the factors under investigation. The survey also collected basic details such as age, gender, income level, educational qualification, and professional experience so as to give relevant insights into the population of the respondents. Also, prior to the survey being released, the questionnaire went through tests with a sample of respondents in order to evaluate the clarity and reliability of the questions being asked. Any feedback received was used to adjust the wordings of the questions and improve the overall structure of the questionnaire.We administered a questionnaire to 78 business owners. The questionnaire captured demographic information like age, gender, income, qualification and experience. The questionnaire consisted of 15 Likert scale questions, related to the aim of the study. A 5-point Likert scale was put forth (1 meant strongly disagree, 2 meant strongly agree, 3 was neutral, 4 represented agreements, and 5 was strong disagreement). The questionnaire was carefully integrated to align the study's research objectives and hypotheses. Targeting business owners and entrepreneurs from all over India, the collected data was obtained from relevant sources. After a well-designed literature review, and consultation with business experts, the draft questionnaire underwent pretesting in order to determine its applicability and clarity. Pretesting was a key part of the process, to make sure the data collection experience was optimally refined to be as smooth, systematic and on topic to the study as possible. The questionnaire was developed for self-administration and was designed to be easy to use and a low cost. In an effort to improve the accuracy and efficiency of the responses, the researchers informed the business owners that their responses would be used for academic research. This was done to improve the quality of the data collected and relevancy of the responses in context of the existing use of AI in businesses.

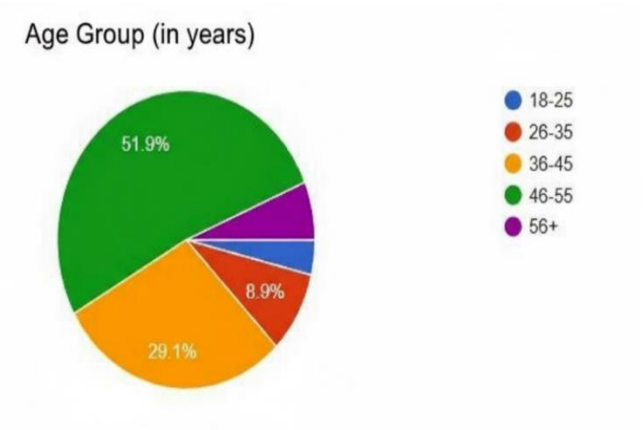

Figure 6: Age category of the respondents of the questionnaire

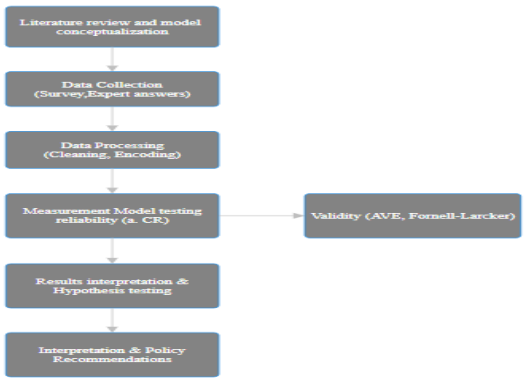

Figure 7: Research process from Data collection to conclusions

Figure 7 outlines how the overall research progresses from the initial model development and the collection of data to processing it and testing it and using it to interpret the results which can then be analysed before drawing policy recommendations.67.1% of the respondents were male, whereas the rest 32.9% consisted of females. 3.8% of the respondents were in the age range of 18-25 years, 8.9% were aged 26-35, 29.1% of the business owners were 36-45 years old, those who were aged between 46-55 made up 51.9% of the respondents, and the rest (6.3%) were above the age of 55 years. Among the respondents, 12.7% earned less than 10 lakh per year, 19% of them earned between 10-25 lakh per year, those who earned 26-50 lakh per year made up 15.2%, 51-100 lakhs was earned by 21.5% and 31.6% of them earned more than 1 crore. All of these values mentioned above were with respect to INR (Indian rupees).

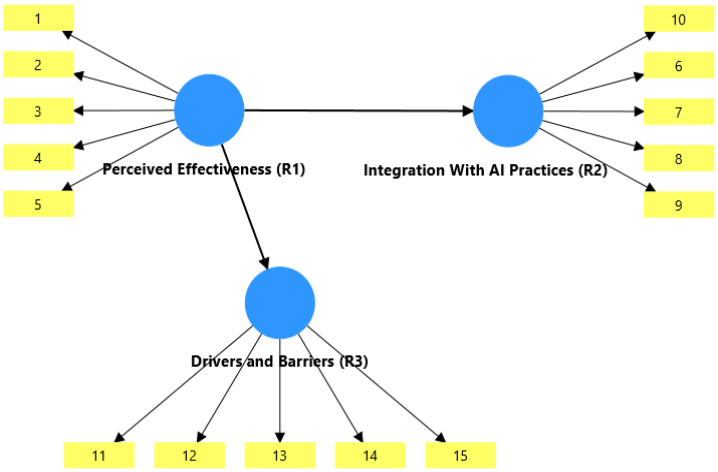

Figure 8: PLS-SEM model showing variables and relationships

Figure 8 shows the PLS-SEM model which includes the structural and measurement parts. This explains how the 15 survey items are connected to their respective variables R1, R2 and R3. This particular model shows how the items measure each variable and how the variables influence each other.

Table 1 : Research and survey on AI generated works

RQ	Research Question	Survey Items	Loadings
R1	How effectively do current IP laws address infringement and ownership issues arising from AI-generated works?	Current IP laws provide clear ownership guidelines for AI-generated creative works.	0.908
		Existing legislation adequately addresses infringement involving AI-created content.	0.913
		Legal definitions of "author" are sufficient to include AI-assisted creation.	0.869
		IP enforcement mechanisms are effective in resolving AI-related disputes.	0.885
		Case law has evolved sufficiently to cover AI-driven authorship issues.	0.914
R2	To what extent can ethical principles of consent, attribution, and compensation be operationalized in the governance of AI creativity?	Consent from human creators should be mandatory before AI uses their work for training.	0.749
		Attribution rules should extend to AI systems as co-creators when applicable.	0.886
		Compensation frameworks for human contributors in AI-generated works are necessary.	0.777

		Ethical guidelines can be integrated seamlessly into national IP frameworks.	0.864
		The absence of ethical safeguards undermines confidence in AI creativity regulation.	0.766
R3	What policy reforms can ensure a balanced framework for rewarding human creators while recognizing the contribution of AI systems?	A tiered rights model differentiating human-authored and AI-generated works is equitable.	0.732
		Policy reforms should limit monetisation of fully AI-generated works.	0.766
		Stakeholder collaboration is essential for effective AI creativity regulation.	0.564
		Global harmonization of IP laws concerning AI creativity is not achievable.	0.776
		Policymakers must incorporate economic and societal impacts in AI-focused IP reforms.	0.586

The table shows how each research question is connected to its survey items and their loadings. The loadings which are higher suggest that the questions are measuring the variables (R1,R2 and R3) effectively which also displays that the data is reliable for analysis.

IV. Results and Discussions

Prior research done on this topic have tried to map out the growth of digital financial services which has been increasing rapidly, showing how important these services prove to be in order to expand the fields of finance, specifically for the populations which are underserved. Efforts have also been made to identify prominent scholars and institutions which constantly work towards these goals and research on the themes of mobile banking, financial literacy and blockchain. This highlights how important fintech has become, being a key driver of sustainable economic development whilst also providing light upon how stronger and more supportive regulatory frameworks and future research on marginalised and vulnerable populations is of the utmost importance, now more than ever. Even gender disparities affect the adoption of financial services due to which alternate financing mechanisms are in need to create a more inclusive financial system that will lead to the long-term growth of economies all around the world. [13] Prior research has also shown how developed and smart cities have grown through digital innovation over the course of many yet the digital disparity within the city keeps on growing along with social inequalities by excluding the low-income inhabitants and the elderly, most of which have limited digital skills. This is because most of the innovations are technology driven and insufficient attention given to make sure that all the citizens of the city take part and benefit from these innovations. Thus, the idea of having a better policy framework was suggested, one which emphasised on how inclusion was to be achieved in the future, actually being implemented and closing in the gap of digital divide that has been constantly rising in the past. [7]

This study uses the (PLS-SEM) Partial least squares structural equation modelling due to its predictive research and latent-variable models with a small to moderate number of reflective indicators using SmartPLS 4 to investigate the relationships across the three research questions. [19]

Table 2: Research Questions and Decision Metrix

Construct	Indicator	Outer Loading	VIF	Decision
R1 (Digital Technologies)	Q1: AI-powered tools reduce barriers to financial access	0.782	2.41	Accepted
	Q2: Blockchain enhances transaction transparency and trust	0.802	2.67	Accepted

	Q3: Cloud-based FinTech lowers service delivery costs	0.835	2.89	Accepted
	Q4: Digital innovations expand reach of formal financial services	0.824	2.73	Accepted
	Q5: FinTech ecosystems bridge the digital divide effectively	0.823	2.70	Accepted
R2 (Policy & Financial Literacy)	Q6: Supportive regulatory frameworks accelerate DFS adoption	0.831	2.51	Accepted
	Q7: Government financial literacy programmes increase uptake	0.850	2.63	Accepted
	Q8: Consumer protection policies build confidence in DFS	0.853	2.71	Accepted
	Q9: Financial literacy initiatives reduce digital exclusion	0.887	3.08	Accepted
	Q10: Interoperability standards support inclusive ecosystems	0.847	2.58	Accepted
R3 (Digital Infra & Financial Inclusion)	Q11: Broadband infrastructure availability drives DFS usage	0.836	2.48	Accepted
	Q12: Mobile penetration expands access to rural populations	0.817	2.33	Accepted
	Q13: Digital payment ecosystems reduce financial exclusion	0.855	2.69	Accepted
	Q14: Infrastructure investment increases long-term financial inclusion	0.888	3.02	Accepted
	Q15: Cross-regional infrastructure disparities perpetuate inequality	0.860	2.76	Accepted

The table shows the Outer Loadings for Measurement Model Indicators which show that all of them are above the recommended threshold.The analysis takes place in two stages, the first one evaluates the measurement model for validity and reliability followed by the structural model using path coefficients, R^2, f^2, and Q^2. This analysis takes into consideration 110 valid responses and includes three reflective latent constructs: R1, Digital Technologies (AI, Blockchain, and FinTech Innovations), measured by Q1–Q5; R2, Policy Frameworks and Financial Literacy, measured by Q6–Q10 and R3, Digital Infrastructure and Financial Inclusion, measured by Q11–Q15.

A. Measurement Model Evaluation

Four criteria were used to examine the measurement model. These were indicator reliability through outer loadings, internal consistency using Composite Reliability (CR) and Cronbach's alpha (α), convergent validity using Average Variance Extracted (AVE), and discriminant validity using the Fornell–Larcker criterion and Heterotrait–Monotrait (HTMT) ratio which are all proven threshold guidelines to ensure that the measurement model is reliable and accurate. The indicator reliability was examined based of the outer loadings of the fifteen indicators across the three constructs. All the outer loadings exceeded the recommended threshold of 0.70 and above which indicates satisfactory reliability. Thus, the results show us that each item is represents its respective latent construct reliably.

4.1.2 Internal Consistency Reliability

This was assessed with the help of Cronbach's alpha (α), and Composite Reliability (CR) which is apt for this model as it allows indicators to contribute differently to the construct. All of the values in the constructs are above 0.90 which indicate excellent reliability. The results show strong reliability of the constructs are shown in the table which are 0.907(R1), 0.931(R2), 0,930(R3), while the Cronbach's α values are 0.882, 0.910, and 0.908 respectively which also confirm satisfactory internal consistency across all the measurement items.

4.1.3 Convergent Validity

This was assessed using the Average Variance Extracted (AVE) for which the values are 0.661(R1), 0.729 for R2, and 0.725 for R3. Since all the values are above 0.50, which is the above the minimum acceptable value, it shows that the constructs demonstrate sufficient convergent validity.

Table 3: Digital Technology and Infrastructure Framework

Construct	**No. of Items**	**Cronbach's α**	**CR**	**AVE**	**√AVE**
R1: Digital Technologies (AI, Blockchain, FinTech)	5	0.882	0.907	0.661	0.813
R2: Policy Frameworks & Financial Literacy	5	0.910	0.931	0.729	0.854
R3: Digital Infrastructure & Financial Inclusion	5	0.908	0.930	0.725	0.852
Threshold	—	**≥ 0.70**	**≥ 0.70**	**≥ 0.50**	**> r**

This table shows all the values surpass the recommended threshold values

4.1.4 Discriminant Validity

Discriminant Validity was analysed using the Fornell-Larcker criteria using the Heteratrait-Monotrait ratio. Under this criterion, the root of AVE should be higher than its correlations with other constructs. As shown in the table, this criterion is surpassed with the values between 0.765 and 0.816 which is below the values obtained by taking the root of AVE which is 0.85. Hence, these constructs show sufficient variation from one another.

B. Structural Model Evaluation

After confirming the reliability and validity of the model, the structural model was assessed using R^2, path coefficients, bootstrapping, effect sizes (f^2), and predictive relevance (Q^2). Bootstrapping was performed using 5,000 subsamples with a two-tailed test and 95% confidence intervals. Collinearity among predictor constructs was also examined before interpreting the structural relationships.

Table 4 : Digital verses Financial Literacy

Construct	R1	R2	R3
R1: Digital Technologies	**0.813**	0.750	0.743
R2: Policy Frameworks & Financial Literacy	0.750	**0.854**	0.712
R3: Digital Infrastructure & Financial Inclusion	0.743	0.712	**0.852**

Table 4 shows Fornell–Larcker Criterion Matrix (Discriminant Validity)

Table 5 : Heterotrait–Monotrait (HTMT) Ratio of Correlations

Construct Pair	HTMT	95% CI (L)	95% CI (U)
R1 ↔ R2	0.816	0.721	0.896
R1 ↔ R3	0.810	0.715	0.889
R2 ↔ R3	0.765	0.668	0.848
Threshold	**< 0.85**	—	—

Table 5 shows the Heterotrait–Monotrait (HTMT) Ratio of Correlations

4.2.1 Collinearity Assessment

The inner Variance Inflation Factor (VIF) was used in evaluating the collinearity. The resulting VIF value is 1,00 for the relationships as R1 is the only predictor of both R2 and R3. This is significantly lower than the 5.0 threshold meaning the intercorrelation is not a concern for the structural model.

4.2.2 Coefficient of Determination (R^2)

This signifies how influencing factors can cause variation in the results. As seen in the table below R^2 values of 0.25, 0.50, and 0.75 are considered weak, moderate, and strong explanatory power, respectively which therefore show that digital technologies do play a role in financial inclusion.

Table 6 : Coefficient of Determination (R^2) and Predictive Relevance (Q^2)

Endogenous Construct	R^2	Q^2	Interpretation
R2: Policy Frameworks & Financial Literacy	**0.562**	0.410	Moderate-to-substantial
R3: Digital Infrastructure & Financial Inclusion	**0.553**	0.401	Moderate-to-substantial
Threshold	**≥ 0.25**	**> 0.00**	—

Table 6 shows the coefficient of determination (R^2) and Predictive Relevance (Q^2)

The results of this study give a clear understanding of the effects on digital financial inclusion due to different factors. This shows that the introduction of cloud-based technologies and blockchain can make a huge difference by improving accessibility and can also help information failure where not everyone has equal information about these technological developments hence making financial inclusion even harder to achieve. Moreover, digital infrastructure was also recognised as an essential factor in deciding the scalability and sustainability, especially in the long term of digital finance initiatives. A major input and insight this study has shown is its recognition of different factors, both systemic and structural which continue to prohibit technological adoption. The results implicated that differences between urban and rural communities, social norms can create high barriers in the effective use of these digital services. Another concern is the algorithmic bias which is caused due to bias algorithms used in automated credit scoring and ones which are used to make important financial decisions. This has serious consequences as it may be bias against vulnerable communities almost acting against them, which gives them a disadvantage in taking advantage of the new technologies implemented. This can only be corrected if there are ethical policies and governance which provide a helping hand in helping to implement these digital financial technologies.This study has implemented a broader approach by connecting the technological innovation with policy coordination compared to previous studies which emphasize mainly on technological efficiency. This proposed framework would attract more interest in investments in financial education which is essential. Though an increase in the technological efficiency would not guarantee financial inclusion, it can certainly be a starting point and when backed up with appropriate policies and knowledge along with security measures, can create a purposeful impact in financial access.

Based on the findings and discussion, the key contributions of the study are:

- Examined how AI, Blockchain, and FinTech support financial inclusion.
- Highlighted digital infrastructure as a key driver of financial access.
- Examined the role of policy frameworks and financial literacy.
- Identified social and regulatory barriers to technology adoption.
- Highlighted algorithmic bias as a risk to vulnerable users.
- Developed an integrated framework linking technology, policy, and financial education.
- Proposed policies for better regulation, cybersecurity, and consumer protection.
- Identified key limitations, including infrastructure and data-related challenges.
- Suggested future research using cross-country and long-term studies.

In terms of policy implementation, the study recommends that strategies employed on a larger scale should focus more on the underserved regions as it is important to ensure that they first have the basic digital necessities so that people can better access and use digital financial services effectively. Another area in which policies need to be directed at is the gender responsive strategies in order to reduce the existing gender inequalities faced on a regular basis in getting access to the digital financial platforms. A more direct approach in these areas along with consumer protection policies and well-built cybersecurity system, would ensure minimal risk and ensure long term growth of these financial services.In spite of its contributions, this study has limitations like the actual implementation of these policies which may create varied results due to the differences in the digital infrastructure and the early stage of implementation. Limitations in data collection along with the short time period of the analysis may prove to make it difficult to judge and predict the long term social and economic benefits or any side effects that may also be caused. Furthermore, for organizations developing new financial technologies, any uncertainties in the regulatory environments may act as a barrier for them to innovate and create new financial technologies.

Therefore, future research should use cross-country approaches to get a better understanding of how financial inclusion evolves and the different factors affecting it depending on the social, economic and regulatory contexts. To get even a greater depth of information, researchers can use capability-based measures to evaluate not only whether people have access to the digital financial platform, but also carry the knowledge that is needed in order to use these platforms efficiently. Also, studies should merge viewpoints from social sciences and technology to further improve future results. Overall, this study demonstrates that sustainable financial inclusion does not only require technology on its own, but also depends on the infrastructure, supportive policies, ethical conventions and cyber security which ultimately leads to attaining sustainable financial growth.

V. Conclusion

This study demonstrates the crucial part which digital technologies take in order to reduce the digital divide and increase financial inclusion in the global economy. This process can be made simpler by the use of cloud-based financial systems and artificial intelligence which are integrated and help increase efficiency, transparency and make financial services more secure. The results confirm that strong digital infrastructure and policy frameworks along with initiatives directing towards financial literacy is quintessential to obtain sustainable financial inclusion. The holistic approach taken for this study is one of the key contributions, going beyond the fully-technology approach taken in most scenarios by considering perspectives of governments and the cultural and ethical concerns as well as the capability development. This study also gives attention to several other unresolved obstacles such as algorithm biasness, social barriers and infrastructural inequalities which have a huge impact in inhibiting outcomes with equal access for everyone. However, this research also has several implications such as the governments supporting and initiating these ideas and strategies that boosts digital adoption whilst maintaining the same and secure standards essential for financial services. The support, no matter how great, needs to be backed by investments which help effective implication of these policies. Not only does this research give new revelations, it also gives opportunities for further research specifically in the long term and cross-regional impacts of digital financial technologies. These studies should focus more on policy frameworks which lead to scalable development which is sustainable as well as adaptable in responding to the rapid technological changes constantly occurring. Overall, this study provides an insightful policy framework to enhance inclusive financial growth and give an input to the academic understanding as well as making a practical implementation.

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